



NATIONAL ASSOCIATION of STATE PUBLIC HEALTH VETERINARIANS, INC.

TO: State Public Health Veterinarians
State Epidemiologists
State Veterinarians
Interested Pet Bird Professionals

FROM: Kathleen A. Smith, DVM MPH
Chair, Psittacosis Compendium

RE: *Compendium of Measures To Control Chlamydophila psittaci Infection Among Humans (Psittacosis) and Pet Birds (Avian Chlamydiosis), 2006*

On behalf of the National Association of State Public Health Veterinarians, I am pleased to provide you with a copy of the *Compendium of Measures to Control Chlamydophila psittaci Infection Among Humans (Psittacosis) and Pet Birds (Avian Chlamydiosis), 2006*. The Compendium committee and consultants believe these updates and revisions will aid public health officials, physicians, veterinarians, and the pet bird industry in controlling this disease in birds and in people.

The 2006 Compendium provides clearer guidance to veterinary clinicians on selecting diagnostic tests, and a discussion of persistent IFA titers. Wording on sentinel surveillance was added, mentioning that it may have value in high risk settings or to mitigate future liability. Protocols for sentinel surveillance must be individualized and established with advice of an avian veterinarian.

To help control this disease and protect public health, the Compendium committee and consultants encourage you to distribute this to health officials, veterinarians, and the pet bird industry in your state and actively promote the document as a standard. We would also like to request that if you update any web links to this document, that you please delete previous Compendiums, as we want to assure that interested people access the most current version. Note that in the future, this document will be reviewed and updated on an as needed basis. The most recent version can be accessed on the National Association of State Public Health Veterinarians website at <http://www.nasphv.org>.

Compendium of Measures To Control *Chlamydophila psittaci* Infection Among Humans (Psittacosis) and Pet Birds (Avian Chlamydiosis), 2006

National Association of State Public Health Veterinarians (NASPHV)

SUMMARY

Psittacosis, also known as parrot fever and ornithosis, is a bacterial infection of humans that can cause severe pneumonia and other serious health problems. It is caused by *Chlamydophila psittaci*, formerly known as *Chlamydia psittaci*. From 1998 through 2004, 146 human cases of psittacosis were reported to the CDC and most resulted from exposure to infected pet birds, usually cockatiels, parakeets, parrots, and macaws. In birds, *C psittaci* infection is referred to as avian chlamydiosis. Infected birds shed the bacteria through feces and nasal discharges, and humans become infected from exposure to these materials. This compendium provides information about psittacosis and avian chlamydiosis to public health officials, physicians, veterinarians, the pet bird industry, and others concerned with controlling these diseases and protecting public health. The recommendations in this compendium provide standardized procedures for controlling avian chlamydiosis in birds, a vital step to protecting human health. This document will be reviewed and revised as necessary.

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Compendium of Measures To Control *Chlamydomphila psittaci* Infection Among Humans (Psittacosis) and Pet Birds (Avian Chlamydiosis), 2006

National Association of State Public Health Veterinarians (NASPHV)

INTRODUCTION

Chlamydomphila psittaci (formerly known as *Chlamydia psittaci*) is a member of the family *Chlamydiaceae*¹. It is a bacterium that can be transmitted from pet birds to humans. In humans, the resulting infection is referred to as psittacosis (also known as parrot fever and ornithosis). Psittacosis typically causes influenza-like symptoms and can lead to severe pneumonia and nonrespiratory health problems. With appropriate treatment, the disease is rarely fatal. From 1998 through 2004, the CDC received reports of 146 cases of psittacosis (mean 20.9, range 11-47).² This is likely an underrepresentation of the actual number of cases. Most reported human cases were associated with exposure to pet birds. Other persons at risk include pigeon fanciers and persons in specific occupations (eg, employees in poultry slaughtering and processing plants, veterinarians, veterinary technicians, laboratory workers, workers in avian quarantine stations, farmers, wildlife rehabilitators, and zoo workers). Human infection can also result from brief exposure to infected birds or their contaminated excretions or secretions.

In this compendium, *C psittaci* infection in birds is referred to as avian chlamydiosis. Chlamydial organisms have been isolated from approximately 100 bird species but are most commonly identified in psittacine (parrot-type) birds, especially cockatiels and budgerigars (parakeets or budgies). Among caged, nonpsittacine birds, infection with *Chlamydiaceae* organisms occurs most frequently in pigeons and doves. Avian chlamydiosis is infrequently diagnosed in canaries and finches. The recommendations in this compendium provide standardized procedures for controlling avian chlamydiosis in the pet bird population, an essential step in efforts to control psittacosis among humans. This compendium is intended to guide public health officials, physicians, veterinarians, the pet bird industry, and others concerned with the control of *C psittaci* infection and the protection of public health.

INFECTION IN HUMANS (PSITTACOSIS)

Transmission

The disease resulting from *C psittaci* infection in humans is called psittacosis and most infections are typically acquired from exposure to psittacine birds. Transmission has also been documented from poultry and free-ranging birds, including doves, pigeons, birds of prey, and shore birds. Infection with *C psittaci* usually occurs when a person inhales organisms that have been aerosolized from dried feces or respiratory tract secretions of infected birds. Other means of exposure include mouth-to-beak contact and handling infected birds' plumage and tissues. Even brief exposures can lead to symptomatic infection; therefore, certain patients with psittacosis might not recall or report having any contact with birds.

Mammals occasionally transmit *Chlamydiaceae* organisms to humans. Certain chlamydial species infect sheep, goats, and cattle, causing chronic infection of the reproductive tract, placental insufficiency, and abortion. Those species are transmitted to humans when humans are exposed to the birth fluids and placentas of infected animals. Another chlamydial species, the feline keratoconjunctivitis agent, may cause rhinitis and conjunctivitis in cats and humans.³

Person-to-person transmission has been suggested but not proven.⁴ Standard infection-control precautions are sufficient for humans with psittacosis, and specific isolation procedures (eg, private room, negative pressure air flow, and masks) are not indicated.

Clinical Signs and Symptoms

The onset of illness typically follows an incubation period of 5 to 14 days, but longer periods have been reported. The severity of the disease ranges from inapparent illness to systemic illness with severe pneumonia. Before antimicrobial agents were available, 15% to 20% of humans with *C psittaci* infection died. Currently, mortality is extremely rare. Humans with symptomatic infection typically have abrupt onset of fever, chills, headache, malaise, and myalgia. They usually develop a nonproductive cough that can be accompanied by breathing difficulty and chest tightness. A pulse-temperature dissociation (fever without increased pulse rate), enlarged spleen, and nonspecific rash are sometimes observed and are suggestive of psittacosis in patients with community-acquired pneumonia. Auscultatory findings can underestimate the extent of pulmonary involvement. Radiographic findings include lobar or interstitial infiltrates. The differential diagnosis of pneumonia caused by psittacosis includes infection with *Coxiella burnetii*, *Mycoplasma pneumoniae*, *Legionella* spp, other *Chlamydiaceae*, and respiratory viruses such as influenza. *Chlamydophila psittaci* can affect organ systems other than the respiratory tract and result in endocarditis, myocarditis, hepatitis, arthritis, keratoconjunctivitis, and encephalitis. Severe illness with respiratory failure, thrombocytopenia, hepatitis, and fetal death has been reported among pregnant women.

Case Definition

The CDC and the Council of State and Territorial Epidemiologists have established case definitions for epidemiologic surveillance.⁵ These definitions should not be used as the sole criteria for establishing clinical diagnoses. A patient is considered to have a confirmed case of psittacosis if clinical illness is compatible with psittacosis and the case is laboratory confirmed by 1 of 3 methods: *C psittaci* is cultured from respiratory secretions, there is a 4-fold or greater increase in antibody against *C psittaci* by **complement fixation (CF)** or **microimmunofluorescence (MIF)** to a reciprocal titer of ≥ 32 between paired acute- and convalescent-phase serum samples, or there is presence of immunoglobulin M antibodies against *C psittaci* by MIF to a reciprocal titer of ≥ 16 . A patient is considered to have a probable case of psittacosis if clinical illness is compatible with psittacosis and the patient is epidemiologically linked to a confirmed human case of psittacosis or the patient has supportive serology (eg, a single antibody titer of ≥ 32 , detected by CF or MIF, in at least one serum sample obtained after onset of symptoms).

Diagnosis

Most diagnoses are established by use of MIF to test for antibodies against *C psittaci* in paired sera. The MIF is more sensitive and specific than the previously used CF tests; however, there is still some cross-reactivity with other chlamydiae, such as *C pneumoniae*, *C trachomatis*, and *C felis*. Certain **polymerase chain reaction (PCR)** assays can be used to distinguish *C psittaci* infection from infection with other chlamydial species. Acute-phase serum specimens should be obtained as soon as possible after onset of symptoms, and convalescent-phase serum specimens should be obtained 2 weeks after the first specimen. Because antimicrobial treatment can delay or diminish the antibody response, a third serum sample might help confirm the diagnosis. All sera should be tested simultaneously at the same laboratory. The infectious agent can also be isolated from the patient's sputum, pleural fluid, or clotted blood during acute illness and before treatment with antimicrobial agents; however, culture of *C psittaci* is performed by few laboratories because of technical difficulty and safety concerns.

Laboratories that Test Human Specimens for *Chlamydiaceae*

Information about laboratory testing is available from most state public health laboratories. Few commercial laboratories have the capability to differentiate chlamydial species. Certain laboratories accept human specimens to confirm *C psittaci* infection (**Table 1**). Other sources might be available.

TABLE 1—Laboratories that test human specimens for *Chlamydophila psittaci*.

Laboratory	Tests performed	Telephone number
Focus Technologies Cypress, California	IFA Panel, PCR, Culture	(800) 445-4032
Laboratory Corp of America, Burlington, North Carolina	Culture	(800) 222-7566
Specialty Labs, Santa Monica, California	MIF (IgM, IgG, IgA)	(800) 421-4449
Viomed Minnetonka, Minnesota	IFA (IgG, IgM) Culture	(800) 582-0077
Respiratory Diseases* Laboratory Section, CDC Atlanta, GA	MIF, PCR, Culture	(404) 639-3563

*CDC is a reference laboratory and samples must be submitted through State Health Departments
MIF = microimmunofluorescence. PCR = polymerase chain reaction assay.

Treatment

Tetracyclines are the drugs of choice.⁶ Most patients respond to orally administered treatment (doxycycline [100 mg, q12h] or tetracycline hydrochloride [500 mg, q6h]). For initial treatment of severely ill patients, doxycycline hyclate can be administered IV at a dosage of 4.4 mg/kg/d (2 mg/lb/d) divided into 2 infusions/d (up to 100 mg/dose). Remission of symptoms usually is evident within 48 to 72 hours. However, relapse can occur, and treatment must continue for at least 10 to 14 days after fever abates. Although in vivo efficacy has not been determined, macrolides are probably the best alternative agents in patients for whom tetracycline is contraindicated (eg, children < 9 years of age and pregnant women).

INFECTION IN BIRDS (AVIAN CHLAMYDIOSIS)

Transmission

Chlamydophila psittaci is excreted in the feces and nasal discharges of infected birds. The organism is environmentally labile but can remain infectious for several months if protected by organic debris (eg, litter and feces). Some infected birds can appear healthy and shed the organism intermittently. Shedding can be activated by stress factors, including relocation, shipping, crowding, chilling, and breeding.⁶

Clinical signs

The usual duration between exposure to *C psittaci* and onset of illness ranges from 3 days to several weeks. However, active disease can appear with no identifiable exposure. Whether the bird has acute or chronic signs of illness or dies depends on the species of bird, virulence of the strain, infectious dose, stress factors, age, and extent of treatment or prophylaxis.⁷

Signs of avian chlamydiosis are non-specific and include lethargy, anorexia, and ruffled feathers. Other signs include serous or mucopurulent ocular or nasal discharge, diarrhea, and excretion of green to yellow-

green urates. Severely affected birds may become anorectic and produce sparse, dark green droppings, followed by emaciation, dehydration, and death.

Case Definitions

A confirmed case of avian chlamydiosis is defined on the basis of one of the following: (1) isolation of *C psittaci* from a clinical specimen, (2) identification of chlamydial antigen by use of immunofluorescence (fluorescent antibody) of the bird's tissues, (3) a ≥ 4 -fold change in serologic titer in 2 specimens from the bird obtained at least 2 weeks apart and assayed simultaneously at the same laboratory, or (4) identification of *Chlamydiaceae* within macrophages in smears or tissues stained with Gimenez or Macchiavello stain.

A probable case of avian chlamydiosis is defined as compatible illness and one of the following: (1) a single high serologic titer in one or more specimens obtained after the onset of signs or (2) *Chlamydiaceae* antigen (identified by use of ELISA, PCR, or fluorescent antibody) in feces, a cloacal swab specimen, or respiratory tract or ocular exudates.

A suspected case of avian chlamydiosis is defined as: (1) a compatible illness that is epidemiologically linked to another case in a human or bird but that is not laboratory confirmed, (2) a subclinical infection with a single high serologic titer or detection of chlamydial antigen, (3) compatible illness with positive results from a nonstandardized test or a new investigational test, or (4) compatible illness that is responsive to appropriate therapy.

Diagnosis

Several diagnostic methods are available for identifying avian chlamydiosis in birds (**Appendix 1**)

Treatment

Treatment should be supervised by a licensed veterinarian (**Appendix 2**).

PREVENTION AND CONTROL RECOMMENDATIONS

Aviary and pet shop owners are encouraged to implement recommendations such as those described in the Model Aviary Program.⁸ Such programs encourage disease prevention and improve animal health and the human-animal bond. To prevent transmission of *C psittaci* to humans and birds, specific control measures are recommended:

- **Protect persons at risk.** Inform all persons in contact with infected birds or contaminated materials about the nature of the disease. When cleaning cages or handling infected birds, caretakers should wear protective clothing, gloves, a disposable surgical cap, and an appropriately fitted respirator⁹ with N95 or higher rating. Surgical masks might not be effective in preventing transmission of *C psittaci*. When necropsies are performed on potentially infected birds, wet the carcass with detergent and water to prevent aerosolization of infectious particles and work under a biological safety cabinet or equivalent.
- **Maintain accurate records of all bird-related transactions for at least one year to aid in identifying sources of infected birds and potentially exposed persons.** Records should include the date of purchase, species of birds purchased, individual bird identification, source of birds, and any identified illnesses or deaths among birds. In addition, the seller should record the name, address, and telephone number of the customer and individual bird identification (eg, band or microchip number).
- **Avoid purchasing or selling birds that have signs consistent with avian chlamydiosis.** Signs include ocular or nasal discharge, diarrhea, or low body weight.
- **Isolate newly acquired, ill, or exposed birds.** Isolation should include housing in a separate air space from other birds and noncaretakers. Isolate birds, including those that have been to shows, exhibitions, fairs, and other events, for at least 30 days, and test or prophylactically treat them before adding them to a group (see Appendix 1 and 2).
- **Test birds before they are to be boarded or sold on consignment.** House them in a room separate from other birds pending test results (see Appendix 1)

- **Screen groups of birds with frequent public contact (eg bird encounters, nursing homes, schools) routinely for anti-chlamydial antibodies and DNA or bacterial protein.** Such testing may be used to reduce potential human exposure from birds. Specific protocols should be established in consultation with an avian veterinarian, recognizing that some birds may demonstrate persistent IgG antibodies in the absence of infection (see Appendix 1).
- **Practice preventive husbandry.** Position cages to prevent the transfer of fecal matter, feathers, food, and other materials from one cage to another. Do not stack cages, and be sure to use solid-sided cages or barriers if cages are adjoining. The bottom of the cage should be made of a wire mesh. Litter that will not produce dust (eg, newspapers) should be placed underneath the mesh. Clean all cages, food bowls, and water bowls daily. Soiled bowls should be emptied, cleaned with soap and water, rinsed, placed in a disinfectant solution, and rinsed again before reuse. Between occupancies by different birds, cages should be thoroughly scrubbed with soap and water, disinfected, and rinsed in clean running water. Exhaust ventilation should be sufficient to prevent accumulation of aerosols and prevent cross contamination of rooms.
- **Control the spread of infection.** Isolate birds requiring treatment. Rooms and cages where infected birds were housed should be cleaned immediately and disinfected thoroughly. When the cage is being cleaned, transfer the bird to a clean cage. Thoroughly scrub the soiled cage with a detergent to remove all fecal debris, rinse the cage, disinfect it (most disinfectants require 5-10 minutes of contact time), and rerinse the cage to remove the disinfectant. Discard all items that cannot be adequately disinfected (eg, wooden perches, ropes, nest material, and litter). Minimize the circulation of feathers and dust by wet-mopping the floor frequently with disinfectants and preventing air currents and drafts within the area. Reduce contamination from dust by spraying the floor with a disinfectant or water before sweeping it. Do not use a vacuum cleaner because it will aerosolize infectious particles. Frequently remove waste material from the cage (after moistening the material), and burn or double-bag the waste for disposal. Care for healthy birds before handling isolated or sick birds.
- **Use disinfection measures.** All surfaces should be cleaned thoroughly before disinfection. *Chlamydophila psittaci* is susceptible to most disinfectants and detergents as well as heat; however, it is resistant to acid and alkali. Examples of effective disinfectants include 1:1,000 dilution of quaternary ammonium compounds (eg, Roccal or Zephiran), 1% Lysol or 1:32 dilution of household bleach (ie, ½ cup/gallon). Many disinfectants are respiratory irritants and should be used in a well-ventilated area. Avoid mixing disinfectants with any other product.

Recommendations for Treating and Caring for Infected and Exposed Birds

All birds with confirmed or probable avian chlamydiosis should be isolated and treated, preferably under the supervision of a veterinarian (Appendix 2). Suspect or exposed birds should be isolated and retested or treated. Treated birds can be reinfected and should not be exposed to untreated birds or other potential sources of infection. To prevent reinfection, contaminated aviaries should be thoroughly cleaned and disinfected several days before treatment ends. General recommendations should be followed when treating and caring for birds with confirmed, probable, or suspected avian chlamydiosis.

- Protect birds from undue stress (eg, chilling or relocation), poor husbandry, and malnutrition. These problems reduce the effectiveness of treatment and promote the development of secondary infections with other bacteria or yeast.
- Observe the birds daily, and weigh them every 3 to 7 days. If the birds are not maintaining weight, have them reevaluated by a veterinarian.
- Remove oyster shell, mineral blocks, and cuttlebone. High dietary concentrations of calcium and other minerals inhibit the absorption of tetracyclines.
- Isolate birds that are to be treated in clean, uncrowded cages.
- Clean up all spilled food promptly; wash food and water containers daily.
- Provide fresh water and appropriate vitamins daily.
- Continue medication for the full treatment period to avoid relapses. Birds can appear clinically improved and have reduced chlamydial shedding after one week.

Responsibilities of bird owners, physicians, and veterinarians

Humans exposed to birds with avian chlamydiosis should seek medical attention if they develop influenza-like symptoms or other respiratory tract illnesses. The physician should consider psittacosis in ill patients exposed to birds and collect specimens for laboratory analysis. Early and specific treatment for psittacosis should be initiated. Most states require physicians to report cases of psittacosis to the appropriate state or local public health authorities. Timely diagnosis and reporting can help identify the source of infection and control the spread of disease. Local and state authorities may conduct epidemiologic investigations and institute additional disease control measures. Birds that are suspected sources of human infection should be referred to veterinarians for evaluation and treatment. Avian chlamydiosis is not a rare disease among pet birds. Veterinarians should consider a diagnosis of avian chlamydiosis for any lethargic bird that has nonspecific signs of illness, especially if the bird was recently purchased. If avian chlamydiosis is suspected, the veterinarian should submit appropriate laboratory specimens to confirm the diagnosis. Laboratories and attending veterinarians should follow local and state regulations or guidelines regarding case reporting. Veterinarians should work closely with authorities on investigations and inform clients that infected birds should be isolated and treated. In addition, they should educate clients about the public health hazard posed by *C. psittaci* and the appropriate precautions that should be taken to avoid the risk for transmission.

Local and state epidemiologic investigations

Local health authorities should report suspected cases to their state health department. Public health and animal health authorities at the local or state level may need to conduct epidemiologic investigations to control the transmission of *C. psittaci* to humans and birds. An epidemiologic investigation should be initiated if a bird with confirmed or probable avian chlamydiosis was procured from a pet store, breeder, or dealer within 60 days of the onset of signs of illness; a person has confirmed or probable psittacosis; or several suspect avian cases have been identified from the same source. Other situations can be investigated at the discretion of the appropriate local or state public health department or animal health authorities.

Investigations involving recently purchased birds should include a visit to the site where the infected bird is located and identification of the location where the bird was originally procured (eg, pet shop, dealer, breeder, or quarantine station). Authorities should document the number and types of birds involved the health status of potentially affected persons and birds, locations of facilities where birds were housed, relevant ventilation-related factors, and any treatment protocol. Suspect birds should be tested as recommended (Appendix 1). Examination of sales records for other birds that had contact with the infected bird may be considered.

Quarantine of birds

The appropriate animal or public health authorities may issue an official quarantine for all affected and exposed birds on premises where *C. psittaci* infection has been identified. The purpose of imposing a quarantine is to prevent further pathogen transmission. Reasonable options should be made available to the owners and operators of pet stores. Preferably, the owner of quarantined birds should treat the birds in a separate quarantine area to prevent exposure to the public and other birds. Alternatively, and with the approval of authorities, the owner can sell the birds after at least 7 days of treatment, provided that the new owner agrees in writing to continue the quarantine and treatment and is informed of the disease hazards. After completion of the treatment or removal of the birds, a quarantine can be lifted when the infected premises are thoroughly cleaned and disinfected. The area can then be restocked with birds.

Bird importation regulations

Large-scale commercial importation of psittacine birds from foreign countries ended in 1993 with the implementation of the Wild Bird Conservation Act.¹⁰ Limited importation of personal pets and avicultural specimens is permitted at this time. Illegally imported (smuggled) birds are a rare but potential source of new *C. psittaci* infection to domestic flocks and should be avoided. The Veterinary Services of the Animal and Plant Health Inspection Service, USDA, still regulates the legal importation of pet birds to ensure that exotic poultry diseases are not introduced into the United States.¹¹ These regulations are set forth in the Code of Federal Regulations, Title 9, Chapter 1. Current minimum treatment protocols under these regulations are not always sufficient to resolve infection in all birds.

Appendix 1

TESTING METHODS FOR *C. PSITTACI*

Bacteria are classified as *Chlamydophila psittaci* on the basis of shared biochemical characteristics and genome composition. The individual chlamydial organisms that meet these classification criteria are not identical and represent life forms that have evolved, and continue to evolve, through infection of both ancient and naïve hosts. Diversity in the organism, the level of exposure, and the host response may cause aberrant test results in some individual animals.

Diagnosis of avian chlamydiosis can be difficult, especially in the absence of clinical signs. A single testing method might not be adequate. Therefore, use of a combination of culture, antibody-detection, and antigen-detection methods is recommended, particularly when only one bird is tested. Although there is no epidemiologic evidence of increased risk to young, elderly, or immunocompromised humans, more rigorous testing should be considered for birds in contact with these individuals. Consultation with an experienced avian veterinarian may help when selecting tests and interpreting results. Proper sample collection techniques and handling are critical for obtaining accurate test results.

Pathologic diagnosis

In birds that show signs of avian chlamydiosis, cloudy air sacs and enlargement of the liver and spleen may be observed, but no specific gross lesion is pathognomonic. Chromatic or immunologic staining of tissue or impression smears can be used to identify organisms in necropsy and biopsy specimens.

Bacteriologic culture

Use of culture is recommended to avoid limitations associated with other tests. Tissue specimens from the liver and spleen are the preferred necropsy specimens. In live birds, combined conjunctival, choanal and cloacal swab specimens or liver biopsy specimens are ideal for diagnosis. Live birds being screened for *C. psittaci* might not shed the microorganism daily. Therefore, to optimize recovery, serial specimens should be collected for 3 to 5 consecutive days and pooled before bacteriologic culture.

Chlamydophila spp are obligate intracellular bacteria that must be isolated in tissue culture or chick embryos. Specialized laboratory facilities and training are necessary for reliable identification of chlamydial isolates and adequate protection of microbiologists. The diagnostic laboratory should be contacted for specific procedures required for collection and submission of specimens. The proper handling of specimens is critical for maintaining the viability of organisms for culture, and a special transport medium is required. Following collection, specimens should be refrigerated and sent to the laboratory packed in ice but not frozen.

Tests for antibodies

A positive serologic test result is evidence that the bird was infected by *Chlamydiaceae* at some point, but it might not indicate that the bird has an active infection. False-negative results can occur in birds that have acute infection when specimens are collected before seroconversion. Treatment with an antimicrobial agent can diminish the antibody response. However, IgG titers may persist following successful treatment.

When specimens are obtained from a single bird, serologic testing is most useful when signs of disease and the history of the flock or aviary are considered and serologic results are compared with WBC counts and serum activities of liver enzymes. A greater than 4-fold increase in the titer of paired samples or a combination of a titer and antigen identification is needed to confirm a diagnosis of avian chlamydiosis.

- **Elementary-body agglutination (EBA)** - The elementary body is the infectious form of *C psittaci*. Elementary-body agglutination is commercially available and detects IgM antibodies, an indicator of early infection. Titers > 10 in budgerigars, cockatiels, and lovebirds and titers > 20 in larger birds are frequently detected in cases of recent infection. However, increased titers can persist after treatment is completed.
- **Indirect Fluorescent Antibody Test (IFA)** - Polyclonal secondary antibody is used to detect host antibodies (primarily IgG). Sensitivity and specificity varies with the immunoreactivity of the polyclonal antibody to various avian species. Low titers may occur because of non-specific reactivity.
- **Complement fixation (CF)** - Direct CF is more sensitive than agglutination methods. False-negative results are possible in specimens from parakeets, young African gray parrots, and lovebirds. High titers can persist after treatment and complicate interpretation of subsequent tests. Modified direct CF is more sensitive than direct CF.

Tests for antigen

Tests for antigen detect the organism. These tests give rapid results and do not require live, viable organisms; however, false-positive results from cross-reacting antigens can occur. False-negative results can occur if there is insufficient antigen or if shedding is intermittent. As with all nonculture tests, results must be evaluated in conjunction with clinical findings.

- **Enzyme-Linked Immunosorbent Assay (ELISA)** - ELISA tests were originally developed for identification of *Chlamydia trachomatis* in humans. The exact sensitivity and specificity of these tests for identifying other *Chlamydiaceae* are not known. They are now used to identify suspected *C psittaci* in birds. If a bird has a positive ELISA result but is healthy, the veterinarian should attempt to verify that the bird is shedding antigen via isolation of the organism. When a clinically ill bird has a negative ELISA result, a diagnosis of avian chlamydiosis cannot be excluded without further testing (eg, culture, serologic testing, or polymerase chain reaction [PCR] assay).
- **Immunofluorescent Antibody Tests (IFA)** - Monoclonal or polyclonal antibodies, fluorescein staining techniques, and fluorescent microscopy are used to identify the organism in impression smears or other specimens. These tests have similar advantages and disadvantages to ELISA.

Tests for DNA

Numerous laboratories offer diagnostic testing using **polymerase chain reaction assay (PCR)**. PCR amplification can be sensitive and specific for detection of target DNA sequences in collected specimens (eg, combined conjunctival, choanal and cloacal swab specimens and blood). Results differ between laboratories because there are no standardized PCR primers and laboratory techniques and sample handling vary. Because of the sensitivity of the assay, samples for PCR must be collected using techniques to avoid contamination from the environment or other birds. PCR does not differentiate between viable and nonviable microorganisms. Test results must be interpreted in light of clinical presentation and other laboratory tests.

Additional tests

Additional diagnostic techniques, such as rapid immunomigration (RIM), are in use or under development. Readers are encouraged to research peer-reviewed reports on such tests before use.

Laboratories that test avian specimens for *C psittaci*

Certain state diagnostic laboratories and veterinary colleges perform routine chlamydial diagnostic tests. Other sources might be available. Inclusion in this list does not imply endorsement by the National Association of State Public Health Veterinarians or constituent institutions.

Table 2: Laboratories that test avian specimens for Chlamydiaceae

Laboratory	Tests performed	Telephone
Diagnostic Center for Population and Animal Health, Michigan State University, East Lansing, MI	RIM (antigen)	(517) 353-2296
ANTECH Diagnostics, Farmingdale, NY	ELISA, IFA* fecal antigen* CF,* PCR,* serum antibody titer*	(800) 745-4725
Avian and Exotic Animal Clin Path Labs, Wilmington, Ohio	IFA, EBA PCR (DNA probe)*	(800) 350-1122 (937) 383-3347
California Avian Laboratory, EL Dorado Hills, Calif	DFA, PCR,* EBA*	(916) 933-0898 (877) 521-6004
Comparative Pathology Laboratory, University of Miami School of Medicine, Miami, Fla	ELISA (antigen), IFA	(800) 596-7390
Infectious Diseases Laboratory (IDL), University of Georgia College of Veterinary Medicine, Athens, Ga	IFA* PCR (swabs, tissue) PCR (blood)	(706) 542-8092
Research Associates Laboratory, Dallas, Tex	PCR (DNA probe)	(972) 960-2221
Veterinary Medical Diagnostic Laboratory (VMDL) College Station, Tex	Isolation, PCR (DNA probe), EBA, CF	(979) 845-3414 (888) 646-5623

*Specimens forwarded to another laboratory.

*CF = Complement fixation. EBA = Elementary body agglutination; ELISA= Enzyme-linked immunosorbent assay. IFA = Immunofluorescent antibody. PCR =Polymerase chain reaction assay. RIM= Rapid immunomigration.

Appendix 2

TREATMENT OPTIONS FOR BIRDS WITH AVIAN CHLAMYDIOSIS

Treatment of avian chlamydiosis can be difficult. Although treatment protocols are usually successful, knowledge is evolving and no protocol ensures safe treatment or complete elimination of infection in every bird. Therefore, treatment for avian chlamydiosis should be supervised by a licensed veterinarian after consultation with an experienced avian veterinarian. During treatment, suggestions in the section "Treatment and care for infected birds" should be followed. The recommended treatment period for avian chlamydiosis has historically been 45 days, except as noted below. Dietary calcium (eg, cuttle bone, mineral block, oyster shell, and highly supplemented pellets) reduces absorption of orally delivered tetracycline so supplementation should be avoided during treatment. In hand-fed neonates where dietary calcium is required, the calcium and tetracycline should be given at least 4 to 6 hours apart.

Treatment Using Doxycycline

Doxycycline is presently the drug of choice for treating birds with avian chlamydiosis. It is better absorbed and more slowly eliminated than other tetracyclines. This allows doxycycline to be effective with lower drug doses (improving palatability with food or water-based administration) or administered less frequently (improving ease of treatment). Treated birds should be monitored for signs of doxycycline toxicosis. Toxicosis can cause general signs of illness (signs of depression, inactivity, and decreased appetite), green- or yellow-stained urine, and altered results of hepatic tests (high serum activities of aspartate aminotransferase and lactate dehydrogenase and high serum concentration of bile acids). If toxicosis occurs, administration should be stopped and supportive care provided until the bird recovers. Treatment with a different regimen or lower doxycycline dose can be started at a later date.

- **Doxycycline medicated feed for budgerigars and cockatiels**—The following medicated diet¹² can be used to treat avian chlamydiosis: Mix 1 part cracked steel oats with 3 parts hulled millet (measured by volume). Add 5 to 6 mL of sunflower oil/kg of the oat-seed mixture, and mix thoroughly to coat all seeds. Add 300 mg of doxycycline hyclate (from capsules)/kg of oat-seed-oil, and mix thoroughly to ensure that oats and seeds are evenly coated. Mix fresh medicated oat-seed mix daily. Feed as the sole diet for 30 days. The oats and hulled millet seed are available at health food stores. Small-sized millet should be selected. Sunflower oil is available in grocery stores. Doxycycline hyclate capsules are available in 50- and 100-mg sizes.
- **Doxycycline medicated water**—Results of pharmacologic studies indicate that doses of 200 to 400 mg of doxycycline hyclate/L of water for cockatiels, 400 to 600 mg/L for Goffin's cockatoos, and 800 mg/L for African gray parrots will maintain therapeutic concentrations.^{13,14} Research data are lacking for other species, but empiric use of 400 mg/L of water has been successful for many psittacine birds. Medicated water failed to maintain therapeutic concentrations in budgerigars.¹² Medicated water should be prepared daily and provided in clean bowls, rather than water bottles.
- **Orally administered doxycycline**—Doxycycline is the drug of choice for oral administration; either the monohydrate or calcium-syrup formulations can be used. Dosage recommendations are as follows: 25 to 35 mg/kg every 24 hours for cockatiels, 25-50 mg/kg for Senegal parrots, and blue-fronted and orange-winged Amazon parrots; and 25 mg/kg every 24 hours for African gray parrots, Goffin's cockatoos, blue and gold macaws, and green-winged macaws. Precise dosages cannot be extrapolated for other species; however, 25 to 30 mg/kg every 24 hours is the recommended starting dosage for cockatoos and macaws, and 25 to 50 mg/kg every 24 hours is recommended for other psittacine species. If the bird regurgitates or refuses the drug, another treatment method should be used.

- **Injectable doxycycline**—Intramuscular injection into the pectoral muscle is often the easiest method of treatment, but not all injectable doxycycline formulations¹⁵ are suitable for IM injection. All available formulations can cause irritation at the injection site. Vibramycin SF I.V^a is a European formulation that can be imported into the U.S. (Table 3). It is effective if administered at doses of 75 to 100 mg/kg, IM, every 5 to 7 days for the first 4 weeks and subsequently every 5 days for the duration of treatment. The injectable hyclate formulation labeled for IV use in humans can be used IV in birds. This formulation is not suitable for IM use because severe tissue reactions will occur at the site of injection.

Injectable Oxytetracycline

Limited information exists to guide the use of an injectable, long-acting oxytetracycline product LA-200.^b Current dosage recommendations are as follows: SC injection of 75 mg/kg every 3 days in Goffin's cockatoos, blue-fronted,¹⁶ and orange-winged Amazon parrots, and blue and gold macaws. This dosage might be suitable for other species but has not been tested. This product causes irritation at the site of injection and is best used to initiate treatment in ill birds or those that are reluctant to eat. After stabilization with oxytetracycline treatment, the birds should receive another form of treatment to reduce the irritation that is caused by repeated oxytetracycline injection.

Chlortetracycline (CTC) Medicated Feed

Chlortetracycline medicated feed has historically been used for flock treatment, however doxycycline regimens are preferred. If used, CTC medicated feed should be the only food provided to the birds during the entire treatment. Birds' acceptance of medicated feed is variable. Thus, food consumption should be monitored. Acceptance can be enhanced by first adapting the birds to a similar, nonmedicated diet. Treatment begins when the birds accept the medicated feed as the sole food in their diet. The following options are available:

- Medicated mash diets (ie, > 1% CTC with < 0.7% calcium) prepared with corn, rice, and hen's scratch.¹⁷
- Pellets and extruded products containing 1% CTC can be used. They are available and appropriate for use with pet birds. Select a pellet size appropriate for the size of bird being treated.^{18, 19}
- A special diet might be necessary for lorries and lorikeets, which feed on nectar and fruit in the wild.²⁰

Experimental Methods

Treatment protocols that use late-generation macrolides and pharmacist-compounded injectable doxycycline are under investigation. Information about these treatment protocols might be available in the scientific literature or from avian veterinary specialists.

Sources of Medications

The following sources (Table 3) are not listed as an endorsement of the companies or products. Other sources might be available.

a. Pfizer Laboratories, London, England

b. Pfizer Laboratories, Exton, Penn.

Table 3: Sources of medication for avian chlamydiosis

Contact	Product	Telephone number
Doxycycline		
Local pharmacies	Doxycycline hyclate capsules 50 & 100 mg Doxycycline calcium oral suspension Doxycycline monohydrate oral suspension Vibramycin 50&100 mg capsules	
Gerry Dorrestein, DVM, PHD Universiteit Utrecht Veterinary Medicine, Utrecht, Netherlands	Vibramycin SF I.V.*	000 316 11 05 76 02 000 313 02 53 3131 (fax) www.NOIVBD.nl info@NOIVBD.nl
Medicated Feed		
Avi-Sci Inc, St Johns, Mich.	Chlortetracycline, 1%	(800) 942-3438
Roudybush, Paso Robles, Calif	Chlortetracycline, 1%	(800) 326-1726
Ziegler Brothers Inc, Gardners, Penn	Chlortetracycline, 1% (special order, 50# min)	(800) 841-6800
Chlortetracycline powder		
Fort Dodge Animal Health, Fort Dodge, Iowa	Aureomycin (tetracycline) soluble powder concentrate, 64 gm/25.6 oz	(877) 747-2030
Phibro Animal Health, Fairfield, NJ	CLTC 100 22% (100 gm/lb)	(888) 475-7355
DurVet, Blue Springs, Mo	CTC-50, soluble powder, 25.6 oz.	(800) 821-5570
*Investigational New Animal Drug Application (INADA) is no longer required, Contact the FDA at (301) 594-0796 about obtaining a personal import letter.		

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Additional Resources

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